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APPLIED EVALUATION OF BIODIVERSITY

CASE STUDY: CZECH REPUBLIC

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FOREWORD

This report was contributed as a national case study to an OECD project on the Applied Evaluation of Biodiversity, being carried out by the Working Group on the Economic Aspects of Biodiversity. It does not necessarily reflect the views of individual OECD Member countries or of the OECD Secretariat. It is published under the responsibility of the Secretary General.

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APPLIED EVALUATION OF BIODIVERSITY

by

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Executive Summary

This paper describes a practical experience of biodiversity valuation in the Czech Republic. The methodology for estimating environmental values of biotypes, originally developed in the Hesse federal state of Germany, was used and applied on the three levels: local (Tlustec case study), regional (highway D8 project) and national (nation-wide evaluation of biotopes of the CR). Hesse methodology offers a scale of expert point values for all basic biotypes inclusive anthropogenic (forest, bushes, gardens, waters, beaches, morass, grasslands, lawns, stone or asphalt surfaces etc.). Point values are transferred into monetary terms by multiplying points by average national restoration costs necessary for keeping the environmental quality of biotypes.

Ecosystem or species studied: There is nothing like biodiversity without territorial framework. That is why the evaluation of ecological quality of a territory is better approach to biodiversity valuation than any other approach not tied with the territorial dimension. Hessian method evaluates ecosystems and species within the eight main characteristics of biotopes.

Valuation method used: In the Czech case study the Hessian method is used, that is based on expert valuation of all kinds of biotopes existing in respective national territory. Any one biotope is valued through Delphi method by a team of ecologists by points according to eight ecological characteristics. Result of such valuation is a list of all biotopes with respective point values that shows the ranking of biotopes according to their ecological quality (biotope's life-supporting potential). Point values are transferred into monetary terms by average national restoration costs necessary per one point. In substance, this method tries to evaluate intrinsic value of nature in monetary terms. In Hesse land these values, expressed in real payments for intervening into territory, have enabled that 45 % of the land are protected areas.

Main lessons learned: Compared to traditional methods based on WTP or WTA concepts, the Hesse method overcomes the shortfalls of an individually based utilitarian approach and can be applied on both microeconomic and macroeconomic levels. By carrying out expert valuations by ecologists it bridges over the traditional concept of economic value as reflection of the use, option and existence values and starts to surpass into the concept of intrinsic value. Elements of intrinsic value can enter into the economic system if in the political decision-making process respective payments are approved and implemented.

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1. General Description

- Description of the ecosystem.
- Description of main impacts.
- Identification of main sources of these impacts.
- Identification of key objectives of the valuation exercise.

1.1 Object of the evaluation

Case studies:

1. The Tlustec hill (local level)
2. The D8 highway project (regional level)
3. The evaluation of the territory of the Czech Republic (nationwide level)

Tlustec

The Tlustec hill is located in the district of Česká Lípa, in the northern part of the Czech Republic. The Tlustec hill is an important deposit of basalt that should be used for the construction of the First Railway Corridor and for other purposes. A small deposit was mined in the past.

At the same time, the hill is an important natural and scenic formation in this region. Its height contrasts with the surrounding plain and the hill is visible from a distance of 30 to 50 km.

Tlustec's surface is of a relatively natural species structure. The vegetation (leafy forest) consists of quality broadleaved species; with red beech and small-leaved lime being the most prevalent trees. An integral complex of original cenoses (which with other habitats forms a surface of the hill) is crucial to the importance of the hill. The vegetation in the top part, in particular, contains natural species. Forest flora and fauna of invertebratea is diversified as well. Based on the evaluation of particular regions by means of seven criteria reflecting natural and landscape value, the Tlustec hill is mentioned as the third most significant hill from 69 hills higher than 400m in the same district.

There is a regional biocentre, "Tlustec", which crosses through the hill and a series of endangered plants and animals exist there. For this reason, the local authority of the district town of Česká Lípa intends to declare the top part of the hill a protected natural area.

The key objective of the valuation exercise was to compare the total environmental value of the hill´s biotopes with the economic benefits of the stone mining.

The main impacts of the exploitation of the stone mine are the occupation of the area on the hill and the conversion of the original biotopes into biotopes of lower environmental value, as well as emissions of solid waste and all the impacts connected with transport.

Protected area České Středohoří

České Středohoří is a hilly region of volcanic origin which occupies an area of 1070 km^2 in Northern Bohemia between the towns of Most and Nový Bor. Since 1976 it has been declared a protected area with a significant part of natural ecosystems of forest and persistent vegetation with many tree species and a number of rare and endangered plant and animal species.

České Středohoří is a unique landscape. Part of the relief is a result of tectonic moves and volcanicity in the Tertiary Period and parallel and subsequent denudation with prevailing basaltic rocks, and the rest consists of trachytic and, on a small scale, andesitic rocks. The area also contains classic hydrothermal minerals. The south-west part of the protected area is one of the best and driest places in the Czech Republic.

From a flora point of view it is one of the most diversified areas in the Czech Republic, besides Pontic-panonian submediterranean and Sarmatian elements there are also Atlantic and Montan elements in the area. Frequent joint occurrence of thermophilic and coldphilic species on screes is remarkable. The occurrence of brook lamprey in Valteřický brook, green lizard in the locations of Labe valley and population changes of black stork are interesting features concerning the fauna of vertebrates. The European beaver is found in the lower watercourse of Labe, between Ústí and Děčín. As concerns the forest vegetative stage, an oak-beech mixture stage prevails with a substantial range from oak to fir-beech.

There have been discussions about the construction of the D8 highway in the direction Prague-Dresden. The most discussed part of its route was the transit through the protected area of České Středohoří. This solution to the choice of highway route contradicts the effective Nature Protection Act.

The key objective of this case study was to compare the loss of the value of the environmental function of the protected area, caused by covering the land with a highway, including highway embankments and hollows, with the economic benefits of its construction. The loss caused by deterioration of the protected landscape area was not considered

The main impacts will arise from the construction of the D8 highway in itself and from subsequent heavy traffic as a source of gaseous and carbonic emissions. These externalities put pressure on the existing ecosystems of the protected area.

The Czech Republic´s territory

The Czech Republic is an inland country lying in the centre of the temperate zone of the northern hemisphere in the central part of Europe. With an area of 78 866 km^2 and 10.2 mil. of inhabitants, it has a population density of 130 inhabitants per km^2. Geographical position, topography, diverse geological and climatic conditions, historic development and long-term economic activities of man determine the current status of nature and landscape in the Czech Republic. Since the 1850s negative trends in the development of nature and landscape have considerably predominated with a heavily disturbed flow of energy and substances in the landscape as well as a high proportion of threatened species among wild plants and animals.

The bulk of the country's territory (54.3%) is covered with ecosystems created by farming. Current agro-ecosystems are characterised by a high proportion of arable land in agricultural production (72.2%), an excessive area of land tracts, low numbers of ecostabilising elements, a high proportion of land

threatened by erosion, general physical, chemical and biological degradation of soils and contamination by pollutants from fertilisers and pesticides.

Forest ecosystems, which originally covered almost the whole territory of what is now the Czech Republic, are nowadays present on 33.3% of the country´s territory. Moreover, native, mostly deciduous forests were replaced by less stable coniferous plantations. The proportion of deciduous trees has declined to 20%. At present, 54% of forests in the Czech Republic are damaged by emissions, which is the highest proportion in Europe, and the trend remains unfavourable.

Water ecosystems are characterised by excessive pollution of water due to the negative impacts of human activity. Straightening watercourses and building artificial river banks, building obstructions in watercourses (in particular weirs and walls of dams), sharply increasing contamination of water by waste waters from human settlements and industry, large-scale drainage (in total, 25.4% of agricultural land), industrial intensification of farming (erosion, chemical fertilizers) and intensification of fish-farming practices have affected the structures and functions of watercourses. The total length of watercourses in the Czech Republic decreased by one third during the 20th century. Many facilities on watercourses are barriers to the migration of many animal species and a lot of fish species are also -threatened.

The landscape as a whole has been exposed to intensification of agricultural and forest production as well as to excessive or unsuitable urbanisation. From the viewpoint of nature conservation, the disappearance of ecotonal areas (ecotone = a transitional zone between two adjacent communities, containing species characteristic of both as well as other species occurring only within the zone), which have a stabilising function and which are characterised by high biological diversity, is a particularly dangerous trend. The landscape has grown smaller as a result of linear facilities construction (such as roads, highways, etc.) and agricultural land consolidation (uniting). Therefore, aesthetic values of the landscape and landscape character have been seriously damaged. In spite of the generally unsatisfactory status of nature, valuable parts of nature in the Czech Republic have been preserved in a relatively good state or in a state which allows for the restoration of basic natural processes over a wider area. To date, 3 national parks, 24 Protected Landscape Areas and 1820 small-size Specially Protected Areas have been designated in the Czech Republic.

The key objective of the evaluation of the environmental function of the Czech Republic’s territory was to estimate the total natural capital of the Czech Republic by valuing the particular biotope aggregates expressed in land-cover items for the whole Czech territory as shown in satellite pictures taken at the beginning of the 1990's.

2. Identification of causes and sources of pressures

2.1 Identification of sectoral activities and resulting pressures through:

- Pollution.
- Conversion and land.
- Non-sustainable use of biological diversity and ecosystems.

Tlustec

If the exploitation of the stone quarry were realized, the forest land resources would decrease and the aesthetic value of the territory would be reduced. At least 50 % of the most valuable cenoses would be damaged due to mining in the top part of the hill. Moreover, successive degradation of remaining ecosystems could be expected as a consequence of the disturbed integral forest complex.

From the geomorphologic point of view, the hill belongs to the region of Ralská upland and to Zákupská upland which is the subsystem of Ralská upland. The basic topographical elements are structural plateaux, basalt protruding from these plateaux, and field vent from denudation.

The mined basalt has very few variable attributes. It is characterised by excellent mechanical strength and resistance against unfavourable climatic conditions. This mineral is useful for production of road, rail and concrete stoneware of the highest quality.

The exploitation would have a lot of negative impacts on the environment and people, such as, in particular, increased noise from mineral extraction and processing and explosions. Other externalities (higher noise level and concentration of pollutants contained in the air) would be caused by the transport of final products from the stone quarry. In the nearest municipalities (Brniště, Luhov and Tlustecká) maximum permissible noise level would be exceeded in case of mining. Pulsed noise is expected to reach 80 dB (a norm permits only 70 dB). Other surrounding municipalities, such as Velký Valtinov and Postřelná; would also be affected.

The decision regarding the exploitation was issued in 1961 and in 1968 the exploitation of the mining area (of 115,6 ha.) began. The estimate of total resources amounts to 37 000 000 m^3 and mineable resources are estimated at about 17 793 700 m^3. If the rate of basalt mining is 600 000 t./$year^{-1}$, the reserve-to-production rate of this deposit would be considered about 83 years.

As with pollution in the whole part of the Czech Republic, the pollution and the disturbance of the hill's environmental function was partly caused by global air pollution due to domestic and foreign emissions. But the mining represents the prevailing main source of the Tlustec hill´s pollution.

The mining in itself is the reason for the land conversion destroying the original ecosystems which are replaced by new ecosystems of lower environmental value.

Regarding the ”Tlustec” regional biocentre which crosses the hill, many plants and animals will be endangered if the exploitation is realised here. Therefore, the mining in this area is a typical example of the unsustainable exploitation of resources.

Protected area České Středohoří

The exception to the Law on Protection of Nature and the Landscape No. 144/1992 Coll. for the D 8 highway route through the České Středohoří protected area was issued on 19 February 2000. The decision was issued by minister of the environment Miloš Kužvart who, on the recommendation of the remonstrance commission, cancelled the decision of the Ministry of the Environment from 20 November 1998, wherewith the exception was not issued.???

The construction of the highway will bring considerable risks of damage to the environment by noise, dust and emissions from vehicles. On the other hand, fluent driving leads to fuel savings, even at higher than average speed, and it will therefore cause a reduction of overall air pollution. Moreover, it can be expected that the newly opened road will take over part of the traffic from other parallel roads which cross the centres of several municipalities. However, inside the protected area all remaining significant biocorridors will be broken off.

From an economic point of view the construction of the highway is unambiguously required. Considering the huge density of transit and intrastate transport in the direction of north-west Europe, as well as the efforts of the Czech Republic to get connected to the European highway network, the pressure to build the highway is getting stronger.

An alternative to the planned construction of the D 8 highway would be to build a tunnel for part of the route. Such a solution would eliminate many problems connected with the construction of the highway. Moreover, the road would be considerably shortened. However, this alternative would create many technological complications and there would be a threat of lowering the level of underground water which could lead to problems with supplies of drinking water to the locality of Velemín.

There are two sources of environmental pollution. Firstly there is the process of the construction of the D 8 highway which is also the reason for the land conversion and the loss of the environmental value of the protected area. Future traffic will be another important source of air pollution.

According to the Law on Protection of Nature and the Landscape No. 144/1992 Coll. there is no possibility to build the highway through the protected area. It was necessary to have an exception to this law. The construction would affect biological diversity and so is contingent on ten special conditions that have to be met.

The Czech Republic´s territory

The purpose of this case study is to estimate a total economic value of environmental functions of each biotope in the Czech Republic and to compare these values. It is then possible to monitor changes in natural capital.

2.2 Identification of underlying causes of biodiversity loss

- Missing markets or non-existent property rights.
- Information failure.
- Institutional failure.
- Enforcement failure.

The Tlustec Hill

The underlying causes of biodiversity loss are linked to the previous regime of central planning and decision making. Non-existent property-rights to the area of Tlustec and to its environmental functions, an absence of legislation and minimal information on planned interference in environment were characteristic for this period. There were no suitable institutional instruments for biodiversity protection. Thus it wasn´t difficult for state enterprise to get a licence for mining. The concerns and opinions of the population at risk were neglected.

Protected area České Středohoří

The property rights to environmental functions of the protected area are owned by the state. The special conditions that are required to be fulfilled should reduce conflict between economic and environment concerns.

The Czech Republic´s territory

As regards biological diversity, it is possible to expect a positive change in favour of ecologically valuable ecosystems. This expectation results from the fact that many pieces of land have been lying fallow since the beginning of the 1990s and a small part of agricultural land has been afforested (afforest = to turn land into forest, to plant with trees).

2.3 Identification of adverse incentives with negative impacts on biological diversity

- Direct and indirect subsidies.
- Market price support.
- Tax incentives.
- Infrastructure provision.

The Tlustec Hill

Geological prospecting was completely subsidised by the state in the former centrally planned Czechoslovak economy. Currently there are no state subsidies for such prospecting, but there is good information from former prospecting that is usually used by firms.

For these geological services and other such activities appropriate infrastructure was created.

Protected area České Středohoří

The construction of the highway is financed mainly from the state budget and partly from European Union funds.

Construction began on some sections of the highway before 1989 during the former regime. A decision in favour of the construction was made centrally without reference to the opinions of citizens. In 1992, the Act No. 114 on the Protection of Nature and Landscape was enacted that forbade transit through protected areas with no possible exception from the law.

Due mainly to long decision making about an exception from the law, the highway has already reached the border of the České Středohoří protected area.

Other factors with negative impacts on biological diversity could be strong public interest in the construction and pressure from other European countries. Berlin has become the new capital of Germany and there are big efforts being made to increase the quickness, capacity and quality of transport systems from Berlin to all cardinal points. An alternative route, Praha – Mladá Boleslav – Görlitz, with a branch to Liberec, would have the same trouble in regard to the Lužické Hory or Jizerské Hory protected areas.

The Czech Republic´s territory

The object of this study is to introduce a new payment for the loss of biological functions in the territory. It is a new positive economic stimulation for the protection of nature and landscape in comparison with present access to natural territory which is free of charge.

3. Impacts on ecosystems

- Impacts on genetic and species diversity.
- Impacts on ecosystem in general.
- Impacts on ecosystem resilience.
- Damage to resource base.

According to the Act No. 114/ 1992 Coll. an ecosystem is defined as a functional system of living and lifeless components of environment which are interlinked by metabolism, energy stream and information transfer and influence each other and develop in certain way.

The Tlustec Hill

The top of the hill is composed of unique leafy forest. According to a consensus of interested experts the most valuable locations are malice grass beechwood with broadleaved limetree, flower stand plantation with an occurrence of lilies (2 ha, north and north-east downhill, 520 – 570 metres above sea-level), flower growth of pepperworts (cca 3 ha, south-east downhill, 520 – 570 metres above sea-level), limetree growth with a conversion to seedling forest of limetree and beech that is rare in Czech terms (10 ha, southern downhill, 470 – 570 metres above sea-level), and the top part of the hill (5 ha, at present time completely deforested).

From the viewpoint of the Tlustec hill´s importance, a total integral complex of original cenoses (which with other habitats forms a surface of the hill) is crucial. Especially a superior vitality gives evidence of good quality of forest cenoses. Invasive species of snapweed poorly flowering are nearly absent in this area. A relatively high number of Scotch elms is preserved here, although they have became extinct in similar locations.

A forest flora and fauna of invertebrates is very well diversified. In 1987 there was a marked occurrence of some distinguished species of higher vertebrates, especially black stork, goshawk, eagle-owl, stock-dove and bats.

The České Středohoří protected area

In regard to ecosystems the České Středohoří protected area is an integral complex. Some ecologists predict that the highway would separate this complex into two parts with different ecosystems and endangered species would be destroyed.

The Czech Republic´s territory

The current status of nature and landscape in the Czech Republic is determined by geographical position, topography, diverse geological and climatic conditions, historic development and long-term economic activities of man. Since the 1850s negative trends in the development of nature and landscape have considerably predominated. They have been amplified during the last few decades. The main cause was economic growth carried out on the basis of free consumption and deterioration of natural resources.

The above-mentioned situation can be illustrated by the heavily disturbed flow of energy and substances in the landscape as well as by the high proportion of threatened species among wild plants and animals. At present the following proportion of species are threatened on the territory of the Czech Republic: mammals 35%, breeding birds 57%, reptiles 100%, amphibians 95%, fishes 28% and higher plants 16%.

In the Czech Republic ecosystems created by farming represent, similarly to most of Europe, the most extensive land-use type, covering 54.3% of the whole country´s territory. The most serious phase in development was the so-called collectivisation in the 1950s, leading inter alia to large-scale destruction of ecostabilising elements in the landscape. In addition, traditional agricultural production was changed into industrial large-scale production in the 1970s. Although the non-productive importance of agro-ecosystems is not doubted, their form and shape have been almost exclusively determined by the technological demands of agricultural production. Therefore, current agro-ecosystems are characterised by a high proportion of arable land in agricultural production (over 72%), an excessive amount of land tracts, low numbers of ecostabilising elements, a high proportion of land threatened by erosion, general physical, chemical and biological degradation of soils and contamination by pollutants from fertilisers and pesticides.

The most serious consequences are loss of natural soil fertility, a sharp decrease of natural water keeping capacity, loss of biodiversity and decline in native wild species numbers.

Forest ecosystems are nowadays present on 33.3% of the country´s territory. The replacement of native, mostly deciduous forests by less stable coniferous plantations is considered to be the most pronounced change, because among all the Central European habitats and habitat types, the deciduous forest contained the plant and animal communities with the highest species richness. In forests with mostly natural species structure, the deciduous broad-leaved wood species reached almost two-thirds dominance while coniferous trees only one-third. Coniferous growths sharply predominate in current forest communities, reaching almost 80% of all trees present. The proportion of deciduous trees has declined to 20%. Coniferous plantations are characterised by low ecological stability which is manifested in low resistance to natural and anthropogenic affects (wind, insects, air pollution). A joint effect of emissions and long-term planting of coniferous monocultures of the same age, seriously damages forest soils (acidification, nutrient cations as positively changed ion, opposed to anion flush-out and release of toxic aluminium.)

The status of water ecosystems is to a large extent formed by the features and status of adjacent ecosystems in a catchment area. On the other hand, disturbed hydroecological stability of an area affects adjacent ecosystems or even threatens their survival.

Fishponds do not have a favourable status. There are 21 000 fishponds in the Czech Republic at present, some of which were restored to a former or normal health condition in the 1990s. There is still a lack of small water reservoirs in the landscape. These significantly increase biodiversity and improve water retention in the landscape.

Many facilities on watercourses are barriers to the migration of a variety of animal species. Therefore, salmon sturgeon and a lot of other fish species have disappeared from the territory of the Czech Republic. In addition, other animal species are threatened, for example both the stone crayfish and freshwater pearl mussel have disappeared from 90% of sites where they occurred in the past. The negative effects caused by man have resulted in such extensive disturbance of water ecosystems that fish species are the most threatened animal group all over the European continent.

The landscape as a whole has been exposed to intensification of agricultural and forest production as well as to excessive or unsuitable urbanisation. Ecological functions of the landscape have been damaged for a long time in large areas by the large-scale extraction of raw materials, particularly soft-coal, stone, high-quality limestone and gravel sands.

The group of mountain landscape types, mostly covered by forests has been critically damaged by high emissions from industry, public utilities and mobile sources. This poses a threat not only to the survival of forests as natural systems, but also to the stability of the water cycle as well as to the long-term use of these landscape types for traditional tourism and leisure.

There have been valuable parts of nature in the Czech Republic preserved in a relatively good state. Under the Act No. 114/ 1992 Coll. Gazette on Protection of Nature and the Landscape, most of the valuable natural areas are protected by species protection conditions.

4. Impacts on economy and welfare: Rationale for the valuation method chosen and results

4.1 The valuation method

- Valuation objectives.
- Description of method chosen and rationale.
- Description of method implementation procedures e.g. survey questionnaires and samples, experts consulted, variables addressed, etc..
- Beneficiaries of inaction and bearers of costs of environment imbalance.
- Description and analysis of results.

For the economic evaluation of environmental assets and their life-supporting quality, an approach which combines the ecological functions of biotopes and the costs of revitalisation of respective biotypes has been developed. We used the methodology of the Hesse federal state of Germany for assessment (specification/statement) of charges (fees) used during the intervention on nature and the countryside [Richtlinien, 1992] which is based on environmental asset valuation combined with observed costs of actually performed recovery and compensatory arrangements (compensatory arrangements do not need to be functionally connected with the intervention).

Total point value for specific biotype was determined by a group of experts (ecologists) from eight ecological characteristics (each in relation to the environmental situation in Hesse, which is comparable with environmental conditions in the Czech Republic), each of which had a potential point value of between one to six points (zero value was excluded).

1. Biotype matureness.
2. Biotype naturalness.
3. Diversity of biotype structures.
4. Diversity of biotype species.
5. Rareness of biotopes.
6. Rareness of species of biotopes.
7. Sensibility (vulnerability) of biotopes.
8. Threat on number and quality of biotopes.

German ecologists used the following procedure to obtain biotope values: The first four characteristics were added together and multiplied by the sum of the remaining four characteristics. The figure obtained was then divided by the maximum possible number of points (576) and multiplied by 100.

[(1 + 2 + 3 + 4) x (5 + 6 + 7 + 8) / 576] x 100 = number of points (3-100)

The final number of points for each biotope (from 3 to 80) points) was converted into a monetary value by multiplying the points obtained by the average restoration cost **(**DM 0.62 per point is therefore the value of average costs calculated from a "basket of different types of measures" with individual cost-levels in a range between DM 0.02 and about DM 10.00 per point **).** In Czech crowns (CZK 12.40 per point) biotope values lie in the range CZK 37-992 per square metre.

Hesse methodology offers a scale of values for all basic biotypes (forest, bushes, gardens, waters, beaches, morass, grasslands, lawns, etc.).

This methodological approach made it possible to estimate the economic values of the environmental life-supporting functions of biotypes within respective agricultural, forest and water ecosystems, based on LC/LU maps. For this purpose a comparison between the Hesse list of biotypes and land cover surfaces was carried out and penetrations identified.

Tlustec

The area of the evaluated territory is 604 400 m^2. It was comprehensively divided into biotopes and then the final number of points (3 611 400) was obtained. The result was converted into a monetary value by multiplying the points obtained by the average restoration costs (CZK 12,4 per point). By using the Hesse method, the value of the environmental functions of the Tlustec area was calculated to be 447 813 600 CZK.

The total value of the environmental functions is high compared to rent benefits from the quarry.

Region's identification: 08/236, age 77 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	1 900	12 600	Beech on acid soil	58		730 800
BK	5 600					
HB	1 300					
BR	3 200					
LP	600					

Region's identification: 12/236, age 119 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	35 300	50 500	Spruce	50		2 525 000
MD	5 100					
BK	2 500					
HB	7 600					

Region's identification: 12Z/236, age 117 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	8 400	84 300	Broad-leaved forest with refined species	68		5 732 400
BK	50 600					
LP	25 300					

Region's identification: 08Y/234, age 82 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	23 500	42 700	Spruce	50		2 135 000
BK	4 300					
MD	6 400					
LP	8 500					

Region's identification: 08Z/234, age 82 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
KL	5 800	57 600	Mixed pine forest	55		3 168 000
BK	23 000					
JS	5 800					
LP	23 000					

Region's identification: 11/234, age 107 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
BK	67 000	111 700	Beech on acid soil	58		6 478 600
LP	44 700					

Region's identification: 12/234, age 120 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
MD	5 000	50 300	Broad-leaved forest with refined species	68		3 420 400
BK	10 100					
LP	35 200					

Region's identification: 14/234, age 140 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
BK	36 800	61 300	Beech on acid soil	58		3 555 400
KL	6 100					
JS	6 100					
LP	12 300					

Region's identification: 14Z/234, age 140 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
BK	35 000	58 200	Beech on acid soil	58		3 375 600
KL	5 800					
JS	5 800					
LP	11 600					

Region's identification: 16/234, age 160 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
BK	11 500	19 200	Broad-leaved forest with refined species	68		1 305 600
LP	7 700					

Region's identification: 06/234, age 64 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
BK	7 600	21 800	Broad-leaved forest with refined species	68		1 482 400
KL	5 500					
JS	2 200					
BR	6 500					

Region's identification: 06Z/234, age 62 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	1 900	19 100	Broad-leaved forest with refined species	68		1 298 800
BK	7 700					
KL	1 900					
LP	7 600					

Region's identification: 07Z/234, age 68 years						
Timber species	Area m^2	Total area in m^2	Biotype	Points per m^2		Total points
SM	6 100	15 100	Mixed forest	60		906 000
BK	3 000					
BR	6 000					

Calculation of regions's value

Area in total	604 400 m^2
Points in total	36 114 000
3.62 CZK per 1 point	**130 732 680 CZK**
12.4 CZK per 1 point	**447 813 600 CZK**

SM = spruce
BK = beech
HB = hornbeam
BR = birch
LP = linden
MD = larch
JS = ash-tree
KL = field maple

The České Středohoří protected area

The evaluation of the environmental functions of the territory, which should be occupied by the D 8 highway, relates only to the Lovosice – Řehlovice segment That is the 15.7 km long part of the highway going through the protected landscape area.

The final value of the environmental functions amounts to around 232 mil. CZK. In comparison to the construction costs, the value of the ecological functions is relatively low due to the fact that two thirds of the highway are planned to be located on agricultural arable lands with low environmental value. The object of this evaluation was only the area that should be covered with the highway, including incidental highway embankments and hollows. The loss of the value of the environmental functions caused by the deterioration of the whole České Středohoří protected landscape area was not considered.

Evaluation of environm. functions of highway D8, part Lovosice-Řehlovice						
part (from-to)	**length in m**	**width in m**	**m^2**	**biotype**	**points/m^2**	**value in CZK**
Lovosice-bridge	1050	65	68250	OP	11	9309300
bridge	200	30	6000	OP	11	818400
bridge-quarry	170	60				0
			4000	intens.used land	13	644800
			4000	sandy int. used land	11	545600
			500	group of trees	33	204600
			1000	artific.veget. areas	7	86800
			100	small gardens	20	24800
			100	road associated land	31	38440
quarry	230	65				0
			14850	sandy int. used land	11	2025540
			100	road associated land	31	38440
orchard	670	60	40200	fruit trees	23	11465040
orchard-forest	1850	80				0
			800	bush belt	59	585280
			131200	OP	11	17895680
			16000	oak forest	56	11110400
spruce forest	180	30	2200	spruce forest	24	654720
bridge	100	30				
bush hillside	60	30				0
			1300	larch nursery	26	419120
			1900	mixed larch forest	59	1390040
crossroad			50000	vegetation	42,5	26350000
bush hillside -int. orchard	440	70	30800			0
			9240	bushes	36	4124736
			3080	int. orchard	14	534688
			18480	OP	11	2520672
int. orchard	150	70	10500	int. orchard	14	1822800
forest	360	60	21600	broad-leaved forest	33	8838720
forest-bridge	850	70	59500	OP	11	8115800
bridge	400	30	12000	OP	11	1636800
bridge-grass field	130	70	9100	OP	11	1241240
grass field	220	50				0
			2300		39	1112280
			8700		21	2265480
orchard	800	70				0

			26000		42	13540800
			27850		53	18303020
			1150		6	85560
			1000		36	446400
bush hillside	200	60				0
			1200	trees	31	461280
			3600	bushes	41	1830240
			7200	grass field	69	6160320
arable land	230	70	16100	OP	13	2595320
grass field with fruit trees	140	70				0
			2940	trees	33	1203048
			980	bush	41	498232
			5880	grass field	69	5030928
arable land	230	30	6900		13	1112280
bushes	180	30	5400		41	2745360
quarry	450	50	22500		14	3906000
tunnel	200	30				0
tunnel exit	50	30	1500	broad-leaved forest	68	1264800
bridge	200	30				0
tunnel	320	30				0
arable land	1950	50	97500		11	13299000
wet forest	180	30	5400		61	4084560
bushes	100	30	3000		41	1525200
arable land	500	50				0
			2500	trees	31	961000
			5000	bushes	41	2542000
			17500	OP	13	2821000
grass field fallow	50	50	2500		39	1209000
arable land	1100	50	55000		13	8866000
wet pond assoc. area	230	50	11500		59	8413400
arable land	1500	60				0
			81000		11	11048400
			9000		20	2232000
	15670					**23200536**

Out of a total of f 15 670m, 10 600m are arable land.
OP = arable land

The Czech Republic´s territory

To combine the e Hesse methodology with the GIS land cover approach (LC, the Hesse biotopes were aggregated into the land cover items (see Table 1).

Table 1 **Values of environmental functions of biotopes in the Czech Republic**

LAND COVER 1:100000	**Points**			**CZK/m^2**	**CZK/m^2**	**CZK/m^2**
	min.	max.	average	min.	max.	average
1.1.1. Continuous urban fabric	3	3	**3**	37	37	**37**
1.1.2. Discontinuous urban fabric	3	7	**5**	37	87	**62**
1.2.1. Industrial or commercial units	3	3	**3**	37	37	**37**
1.2.2. Road and rail networks and assoc. land	3	7	**5**	37	87	**62**
1.2.3. Port areas	23	23	**23**	285	285	**285**
1.2.4. Airports	3	23	**13**	37	285	**161**
1.3.1. Mineral extraction sites	6	18	**12**	74	223	**149**
1.3.2. Dump sites	6	6	**6**	74	74	**74**
1.3.3. Construction sites	6	6	**6**	74	74	**74**
1.4.1. Green urban areas	14	20	**17**	174	248	**211**
1.4.2. Sport and leisure facilities	10	20	**15**	124	248	**186**
2.1.1. Non-irrigated arable land	11	13	**12**	136	161	**149**
2.1.2. Permanently irrigated arable land	13	13	**13**	161	161	**161**
2.2.1. Vineyards	17	17	**17**	211	211	**211**
2.2.2. Fruit trees and berry plantations	14	23	**18,5**	174	285	**229**
2.3.1. Pastures	21	59	**40**	260	732	**496**
2.4.1. Annual crops assoc. with permanent crops	13	23	**18**	161	285	**223**
2.4.2. Complex cultivation patterns	20	44	**32**	248	546	**397**
2.4.3. Agricultural lands with natural vegetation	31	50	**40,5**	384	620	**502**
2.4.4. Agro-forestry areas	31	60	**45,5**	384	744	**564**
3.1.1. Broad-leaved forest	58	72	**65**	719	893	**806**
3.1.2. Coniferous forest	26	62	**44**	322	769	**546**
3.1.3. Mixed forest	44	67	**55,5**	546	831	**688**
3.2.1. Natural grassland	27	59	**43**	335	732	**533**
3.2.2. Moors and heathlands	36	41	**38,5**	446	508	**477**
3.2.4. Transitional woodland-shrub	26	59	**42,5**	322	732	**527**
3.3.1. Beaches,dunes, sand plains	14	39	**26,5**	174	484	**329**
3.3.2. Bare rocks	23	50	**36,5**	285	620	**453**
3.3.3. Sparsely vegetated areas	21	50	**35,5**	260	620	**440**
3.3.4. Burnt areas	21	21	**21**	260	260	**260**
4.1.1. Inland marshes	44	56	**50**	546	694	**620**
4.1.2. Peat bogs	80	80	**80**	992	992	**992**
5.1.1. Stream courses	47	73	**60**	583	905	**744**
5.1.2. Water bodies	35	79	**57**	434	980	**707**

In addition to the approved objectives, we also tried to construct a similar value map of the economic functions of the Czech territory which includes the same land-cover items and combines them with official prices for urban lands, agricultural lands, forests, coal mines, water resources and other areas of economic use. Basic information for the price map of the economic functions of the Czech territory is given in Table 2.

Table 2 **Values of economic functions of the Czech territory**

LAND COVER 1:100000	**CZK/m^2**	
	official prices of economic functions	
1.1.1. Continuous urban fabric	35-1700	accord. to urban size
1.1.2. Discontinuous urban fabric	35-1700	accord. to urban size
1.2.1. Industrial or commercial units	35-1700	accord. to urban size
1.2.2. Road and rail networks and assoc. land	35-1700	accord. to urban size
1.2.3. Port areas	35-1700	accord. to urban size
1.2.4. Airports	35-1700	accord. to urban size
1.3.1. Mineral extraction sites	3000	
1.3.2. Dump sites	0,50	
1.3.3. Construction sites	35-1700	accord. to urban size
1.4.1. Green urban areas	35-1700	accord. to urban size
1.4.2. Sport and leisure facilities	13+0,9-9,5	
2.1.1. Non-irrigated arable land	1,85-9,05	accord. to districts
2.1.2. Permanently irrigated arable land	1,85-9,05	accord. to districts
2.2.1. Vineyards	42	
2.2.2. Fruit trees and berry plantations	42	
2.3.1. Pastures	0,90-4,50	accord. to districts
2.4.1. Annual crops associated with permanent crops	0,90-4,50	accord. to districts
2.4.2. Complex cultivation patterns	21+0,90-9,05	accord. to districts
2.4.3. Agricultural lands with natural vegetation	0,90-4,50	accord. to districts
2.4.4. Agro-forestry areas	18	
3.1.1. Broad-leaved forest	30	
3.1.2. Coniferous forest	22	
3.1.3. Mixed forest	26	
3.2.1. Natural grassland	2,60	
3.2.2. Moors and heathlands	0,50	
3.2.4. Transitional woodland-shrub	0,50	
3.3.1. Beaches,dunes, sand plains	0,50	
3.3.2. Bare rocks	0,50	
3.3.3. Sparsely vegetated areas	0,50	
3.3.4. Burnt areas	0,50	
4.1.1. Inland marshes	0,50	
4.1.2. Peat bogs	0,50	
5.1.1. Stream courses	5	
5.1.2. Water bodies	5	

The economic value of the environmental functions of the Czech Republic´s territory was calculated using biotope values, their areas and the observed costs of actual restoration measures for 32 land cover items integrating the country´s surface. This value (approximately CZK 27.000 billion) is at least twenty-fold higher than the GDP of the Czech Republic. The final result expresses the value of natural capital.

4.2 The role of information and uncertainty in the design and implementation process

- Information about biodiversity value and environmental impacts
- Information about economic impacts
- Technical information
- Cultural (indigenous) knowledge

The Hesse methodology is a deterministic model approach, because it is created by the teamwork of experts. This method uses an average point value for the whole country or a particular territory complex, which means that these values are an average of the real environmental values of all individual biotopes. The application of this approach is relatively easy, because it is not necessary to look at all the biotopes separately. But, then we have to suppose eventual deviations.

Besides being an expression of ecological value, this methodology also enables a comparison between the environmental values and the economic values of the territory to be made. It provides valuable comparing information about the values of ecological and economic functions in an area.

The methodology for estimating environmental values, originally developed in the Hesse federal state of Germany, and nowadays also developed in the Czech Republic, has recently been recommended by the White Paper on Environmental Liability for member countries of the European Union. Practical utilisation of this approach for any individual country envisages to do a specification of biotopes according to specific conditions of respective country and also do an expert re-evaluation according to actual situation of respective biotopes. It means that the same biotopes can have a different value in different countries.

On the other hand, there are different cultural traditions and attitudes towards environmental protection and so the Hesse technique, which enables an objective monetary evaluation to be made , could be a useful instrument for mitigating these differences and establishing uniform approaches to the protection of the environment.

5. Design of policy responses based on valuation results

5.1 Identification of actual or planned incentive measures

- Category of measure (information dissemination, regulation, market incentive, property rights, definition etc.).
- Objective of incentive measures.
- Reason for choosing measures.

The Tlustec Hill

The results of the Tlustec evaluating study showed that the value of the environmental functions of the Tlustec hill is very high in comparison with the economic benefits of mining . However the value of the environmental function is reduced during the mining and this negative external effect connected with mining is not included in the economic decision making of mining companies.

Nowadays the duty to pay fees for mining space and extracted reserve minerals is set by Law No. 44/ 1988 Coll. (on conservation and exploitation of mineral wealth, The Mining Law) and by Decree of the Ministry of the Economy of the Czech Republic No. 617/ 1992 Coll., on details of paying reimbursement for claim (mining space) and extraction of reserve minerals. Organisations have to pay an annual fee for the use of mining space amounting to 10000 CZK for each square kilometre or fraction thereof mining space and 2000 CZK if the mining area is smaller than 2 hectares.

In comparison with the total loss of the environmental function of the territory, the total payments for claims are almost inconsiderable. Thus a new system which would consider the difference of the value of the area before mining and after mining should be established.

These payments for the loss of the ecological function of a territory for the duration of mining should be an income for municipalities and they should be used mainly for improving the ecological functions of the territory in the same municipality.

The České Středohoří protected area

The implementation of the D8 highway project will bring about a reduction of the total environmental value in this area. Therefore, the Administration of the Highways should pay the ecological detriment incurred to the Ministry of the Environment of the Czech Republic. It would be socially desirable. The Ministry of the Environment should use this money for the revitalisation of the environmental function of this territory.

Currently there are imposed charges for the removal of land from the agricultural and forest land. These charges are imposed in order to compensate for a loss of economic benefit of agricultural and forest production and in the case of forests the charges also compensate for a loss of important non-wood-producing environmental functions.

Although some payments for land removal exist in the Czech Republic, they do not relate to a real loss of environmental functions and so a new more corresponding system of payments should also be introduced in the future.

The Czech Republic

Research results obtained from monetary evaluations on a nationwide level are important and contributory in several ways:

They are important in the macroeconomic field of national accounting. By combining the evaluation of the ecological functions of environment in general and the land cover approach, the research results obtained enable one to express and quantify the concept of national natural capital. It will be relatively easy to calculate the total value of the environmental (ecological or life-supporting) functions of the Czech Republic territory, due to digitised maps and PC frameworks. The total value of natural capital will be helpful in greening national accounts and guiding the way to the integration of economy and environment. Changes in natural capital can be monitored by comparing information derived from new

satellite pictures with that from existing satellite pictures. Such information will be extremely important for environmental corrections of traditional macroeconomic indicators like GDP and others.

Research results can be useful in the field of territory (land use) planning and decision-making. By comparing the values of the environmental functions and the economic functions of respective territory we can generate relevant information for political decisions.

These results can also be used for the construction of economic instruments for the stimulation of activities affecting nature and the environment. Such new economic instruments can contribute to changing the behaviour of economic agents in favour of sustainable development.

5.2 Process of implementation and distributional effects

- Beneficiaries of incentive measure and bearers of cost after implementation.
- Participation and negotiation.
- Enforcement and compliance.

An introduction of payments should prevent a disproportionate decrease in the value of natural capital which is caused by the free exploitation of an area for economic purposes. External effects should be included in the decisions about economic activities.

Beneficiaries of incentive measures will not only be people who are influenced by economic activity and their external effects directly, but a whole society and even a whole biosphere. Naturally the bearers of cost after implementation should be the organisation which is going to use a restrictive natural area.

The importance of participation is closely connected with the development of real democracy. It is supposed that concrete economic activities will be carried out with the participation of local residents, which is guaranteed by legislation. Furthermore, participation also consists in human activities improving the environment.

The participation of people in the application of conditions relating to the Hesse methodology has two dimensions in practice. From a qualitative aspect people can express their opinions on some activities, but a quantitative aspect is represented by an economic stimulation to improve the environment. If somebody improves the quality of an area in such way that the value of the environmental function of this area increases, then he should obtain the amount corresponding with the difference of values before improving and after improving.

5.3 Framework and context of implementation

- Explicit legal framework and property rights (formal constraints).
- Cultural, historical and social context (social constraints).
- Institutions concerned (including appropriate government level).
- Internal evaluation and remedial process.

6. Policy relevant conclusions

6.1 Transferability of the experience

The Hesse methodology could be transferable to all countries, but it is supposed (as it was mentioned above) that the list of biotopes and their point values would be specified according to the actual conditions of a country. Transferability was acknowledged not only in Germany, where the method has been applied since 1998 on the federal level, but also by the Commission of the EU in the White Paper on Environmental Liability from 9 February 2000 [COM(2000) 66 final], in which the Hesse method is recommended for the EU member countries as a way of evaluating damage to biodiversity in monetary terms.

In Hesse state the application of this method resulted in more than 40 % of the whole territory becoming protected areas.

It is necessary to take into consideration that this method has to be used only as an additional instrument to legislative arrangements. Legislative and administrative measures prevent some specially protected parts of the territory from being used for economic purposes. They must be respected.

6.2 Lessons learned

Compared to traditional methods based on WTP or WTA concepts , the Hesse method overcomes the shortfalls of an individually based utilitarian approach and can be applied on both microeconomic and macroeconomic levels. By carrying out expert valuations by ecologists it bridges over the traditional concept of economic value as reflection of the use, option and existence values and starts to surpass into the concept of intrinsic value. Elements of intrinsic value can enter into the economic system if in the political decision-making process respective payments are approved and implemented.

6.3 Possible policy advice for implementation

Broad dissemination of this methodological approach and expert specification of biotope values in different countries according to their natural conditions will create quite a new dimension in environmental protection due to internalising the main life-supporting function of environment.